

Proposed Trifurcation of the ASTM F792 Checkpoint Standard: the Quality Assurance and Human Perception Test Objects/Test Methods

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CIRMS Conference 2015
NIST, 101/LR
April 28, 2015



Outline

- Evolution of F792 and rationale for proposed trifurcation
 - F792-**RTO** (**R**outine **T**est **O**bject – quality assurance)
 - F792-**HP** (**H**uman **P**erception – test evaluation by trained inspectors)
 - F792-**OE** (**O**bjective **E**valuation – automated test evaluation, *see later*)
- F792-RTO
- F792-HP

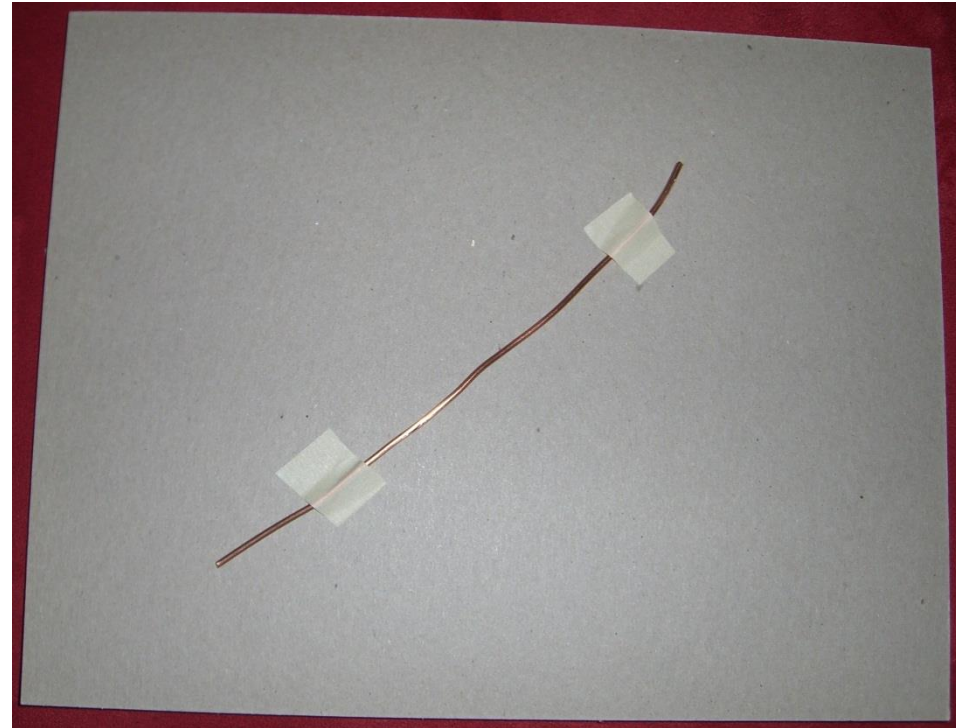
History of Security X-Ray Systems

- Security x-ray systems emerged in late 1960s in response to armed hijackings to Cuba
- By the late 1970s security x-ray systems had evolved into digital devices using either linescan or flying spot technology
- At behest of FAA, ASTM F12.60 was established at that time to develop standards for security x-ray systems and metal detectors

Slide courtesy of Fred Roder (SRA, Intl; TSL)

First X-Ray Image Quality Test Standard (FAA, circa 1972)

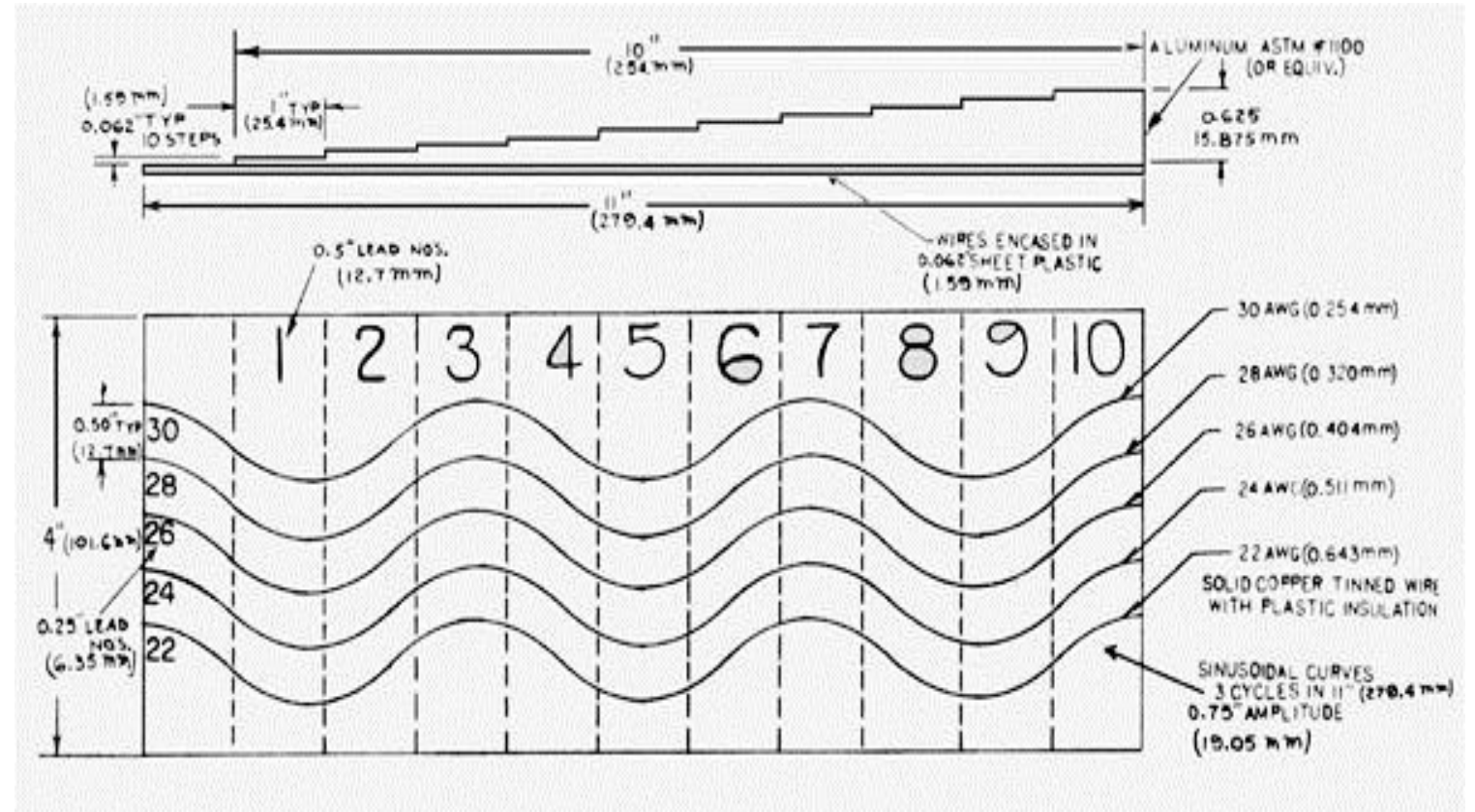
- 24 AWG solid copper wire on cardboard
- Rationale: 20 AWG used in (commercial) detonators
- Test: can any of the wire be seen?



Slide courtesy of Fred Roder (SRA, Intl; TSL)

Second X-Ray Image Quality Test Standard

(Original ASTM F792 – early '80s)



Product was F792 aluminum step wedge with various gauge sinusoidal wires, a design developed by John Battema, Marketing VP for Scanray (later renamed Astrophysics) [Fred Roder (SRA, Intl; TSL)]

Current X-Ray Image Quality Test Standard

(ASTM F792 – 01)

- Dual-energy linescan and backscatter x-ray came later, following the Air India bombing in 1985
- F792 expanded to its current form to address dual-energy and other performance measures in 1988



ASTM X-RAY TEST OBJECT LOG SHEET

TEST	DATE	TIME	OPERATOR	X-RAY MAKE	MODEL	SERIAL #	MONITOR MAKE	MODEL	ORIENTATION (Vertical, Horizontal)	POSITION ON BELT (Left, Middle, Right)
1. Step Wedge										
2. USAF Resolution										
3. Spatial Resolution										
4. Single Resolution										
5. Thin Organic Image										
6. USAF Sensitivity Test										
7. Organic / Inorganic Differentiation										
8. Organic / Inorganic Differentiation										
9. USAF Organic Differentiation										

TEST 3

TEST 4

TEST 6

TEST 8

TEST 5

TEST 9

TEST 7

TEST 1

TEST 2

[Fred Roder (SRA, Intl; TSL)]

Current Image Quality Testing

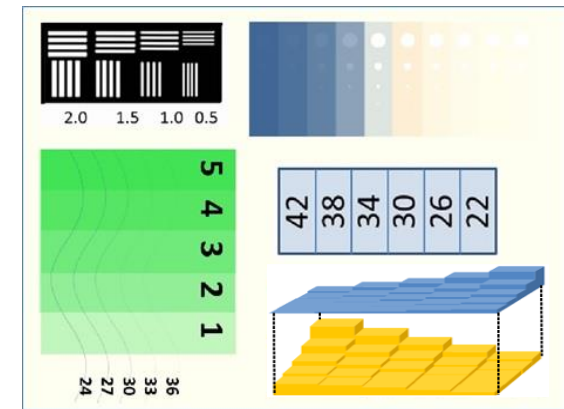


- Currently on market
- *Erroneously* listed as: Security Stepwedge ASTM F 792-88
- Widely used for daily QA

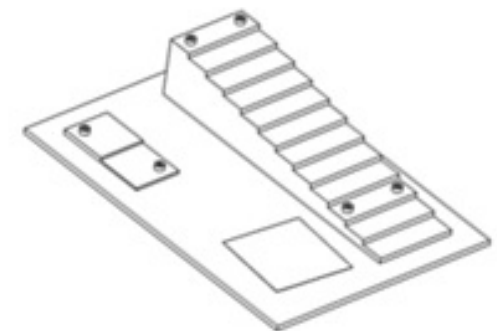


- Mixture of threat-based components, basic IQIs, NDT
- Reflects SoA *ca* 2001

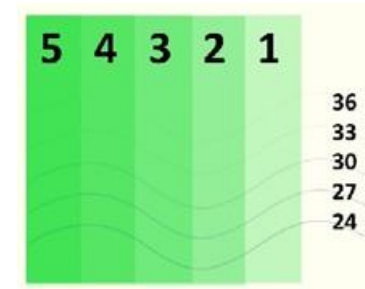
Migration Path ...



-HP

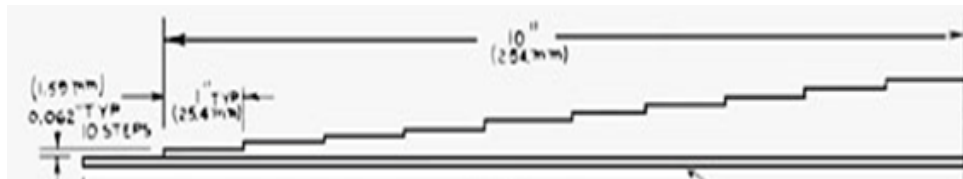
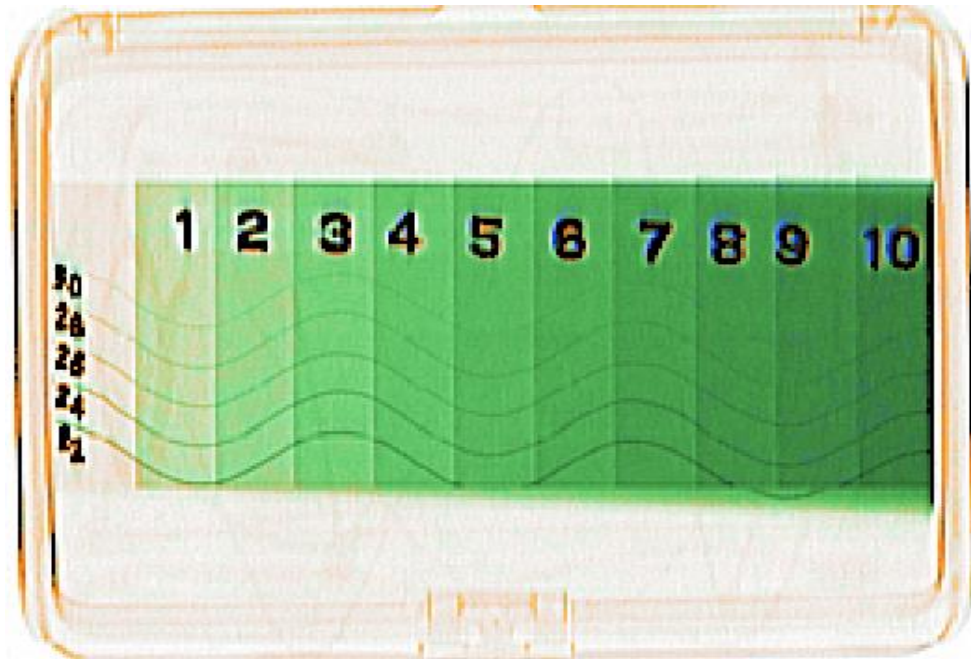


-OE



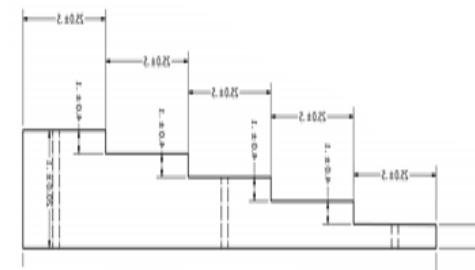
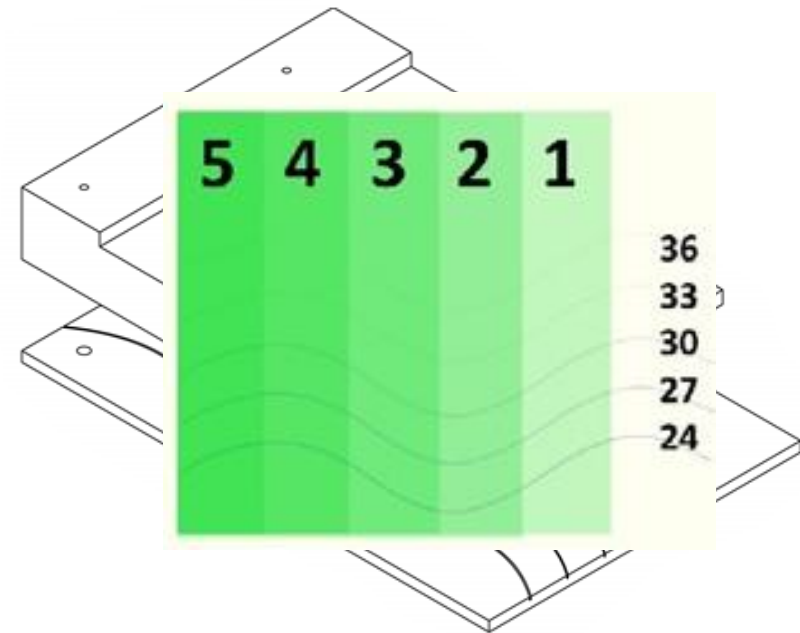
-RTO

"F792-88"



~1.6 mm steps

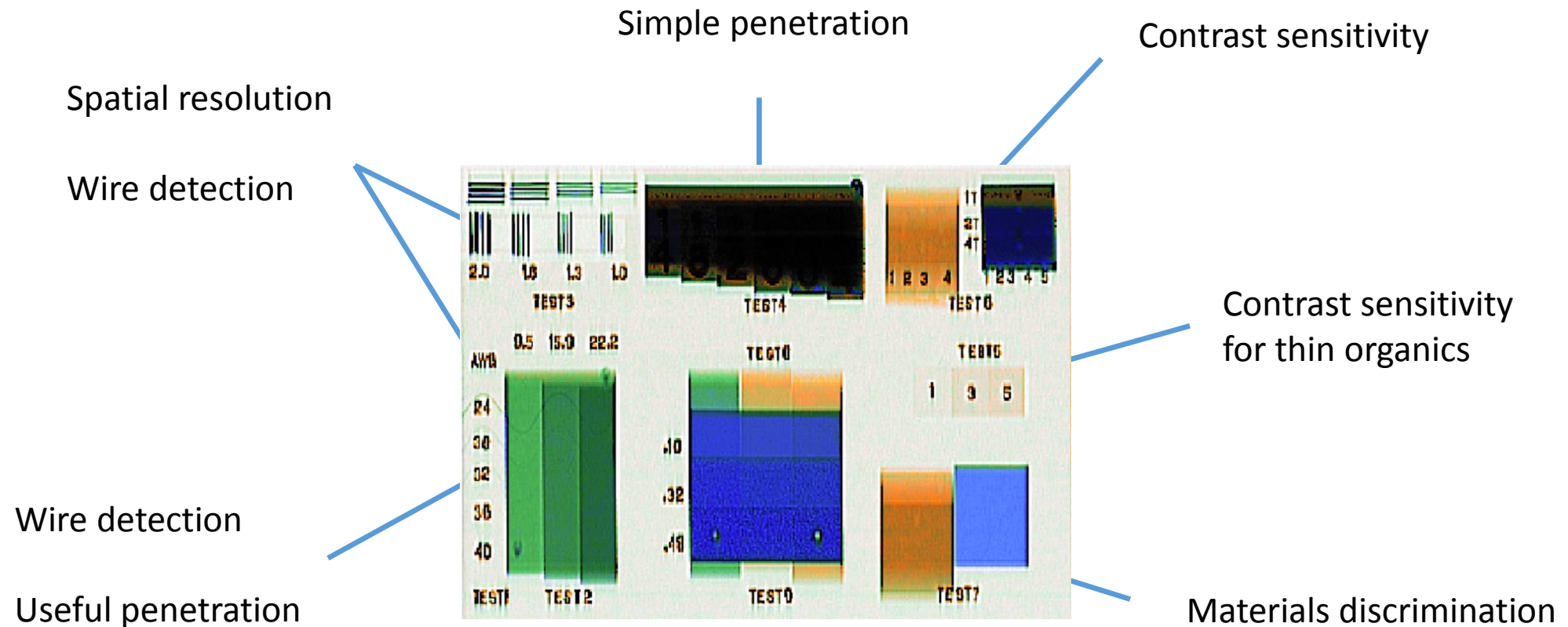
F792-RTO



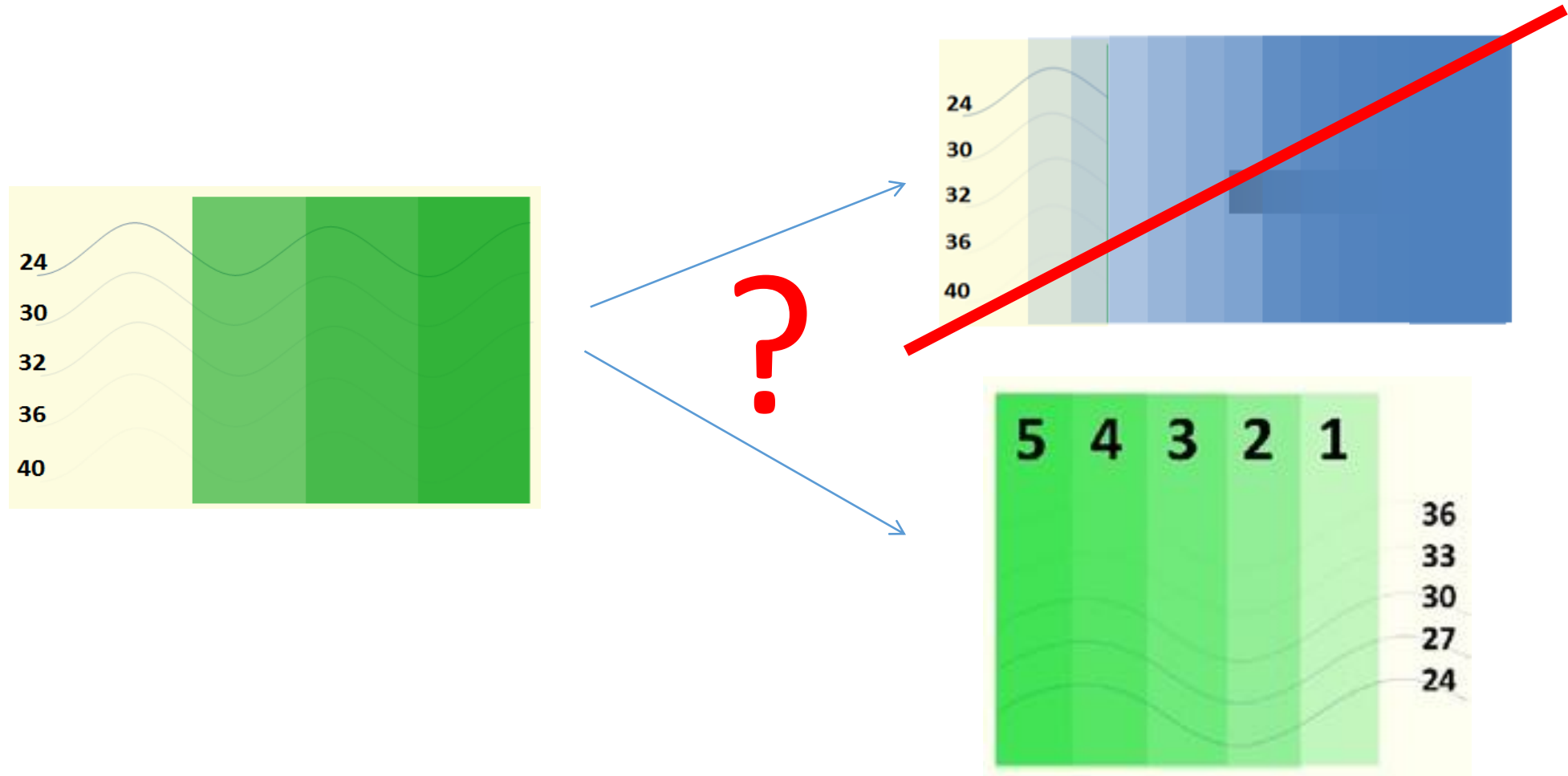
4.0 mm steps

F792-HP ...

“F792 requires a complete rethink!” – Prof Dudley Creagh, Univ of Canberra

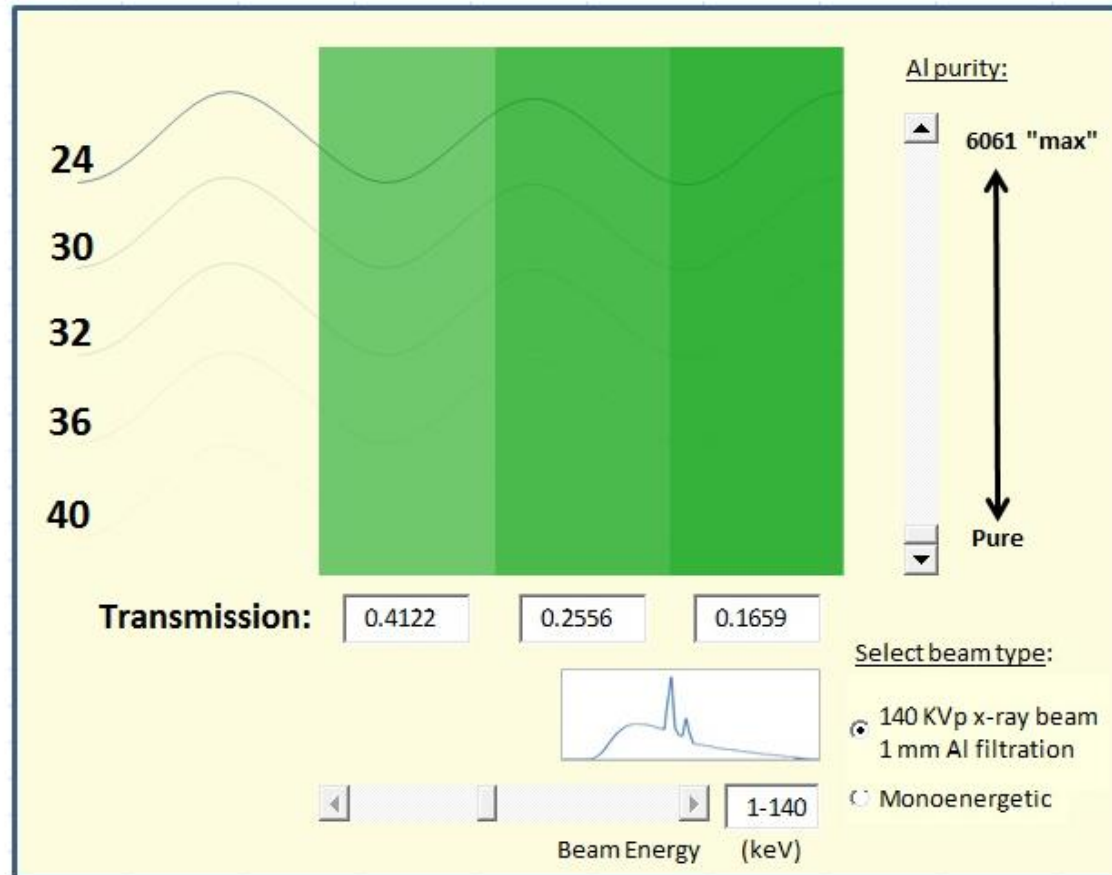
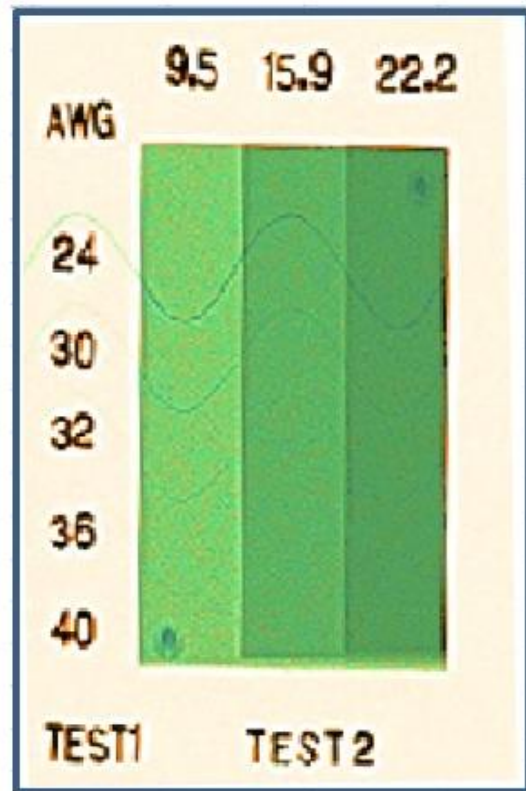


Tests 1,2 – wire detection and useful penetration



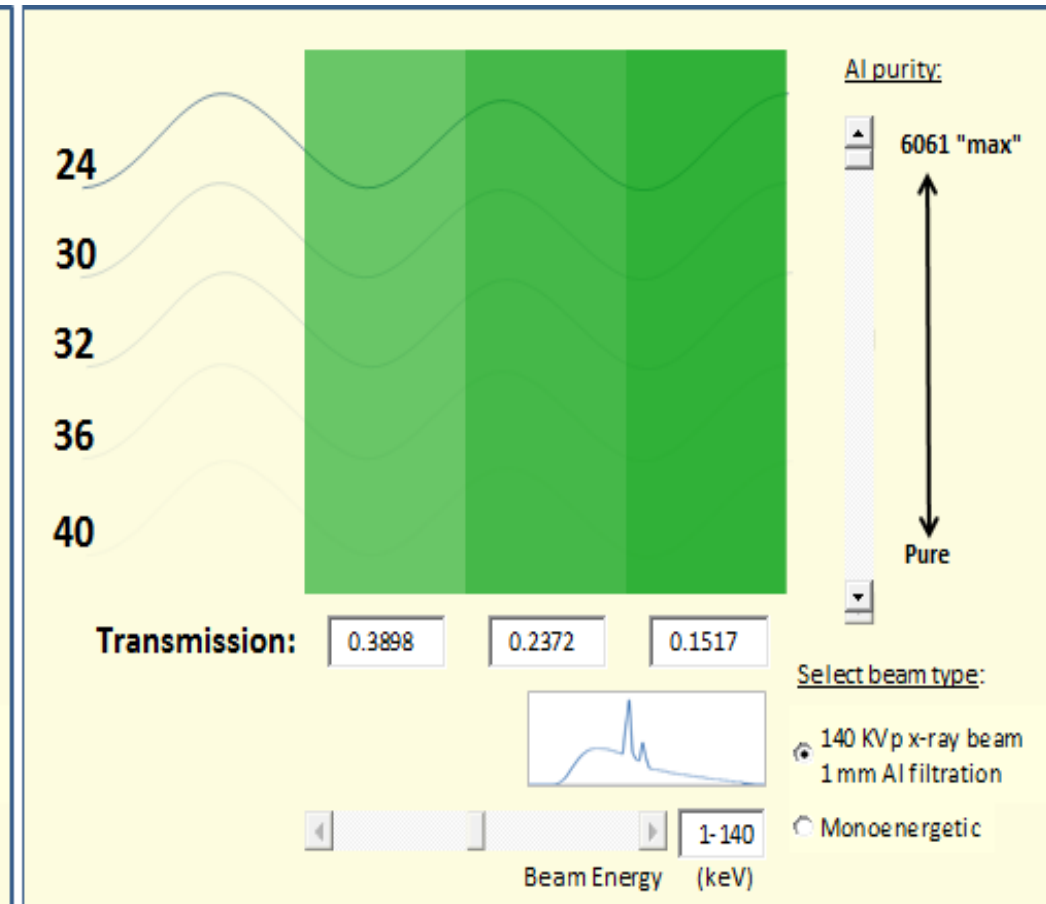
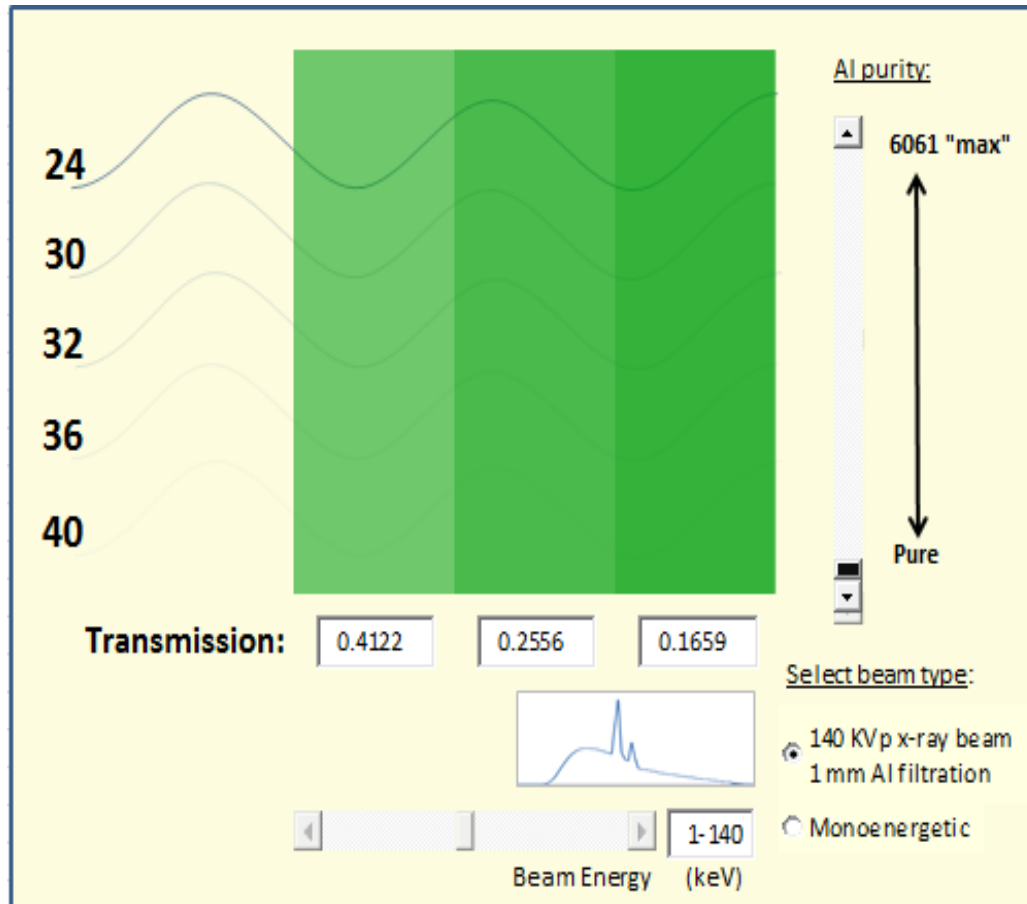
Test 2 – useful penetration cont'd

Which alloy to use ...



Test 2 – useful penetration cont'd

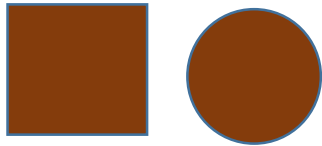
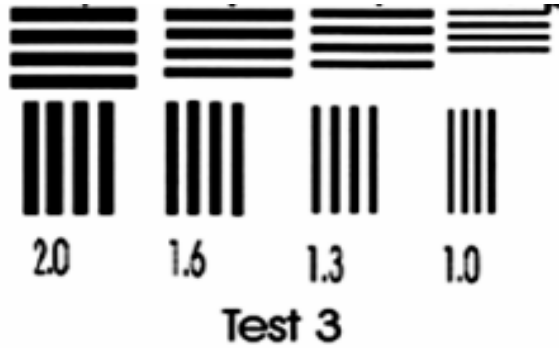
Which alloy to use ... the cheaper ASTM-6061 grade will do.



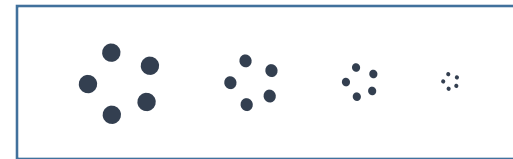
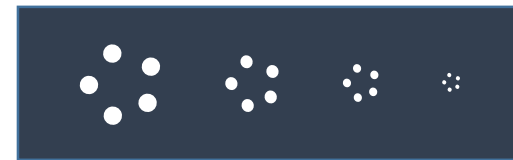
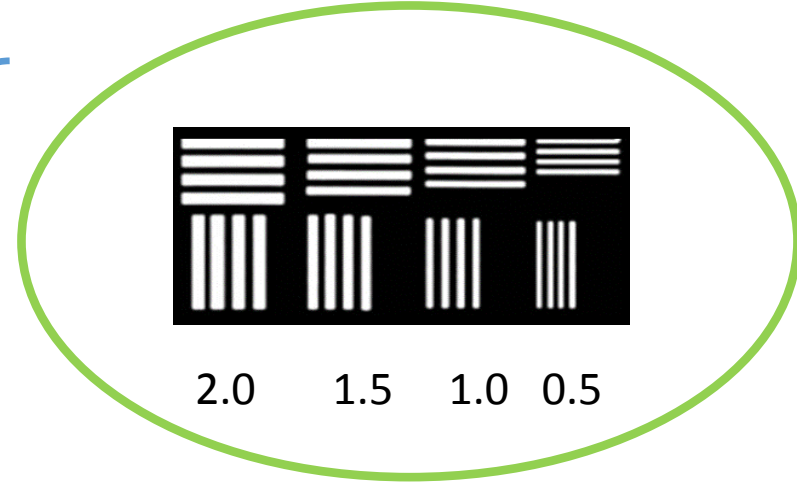
-HP revision status ...



Test 3 – spatial resolution

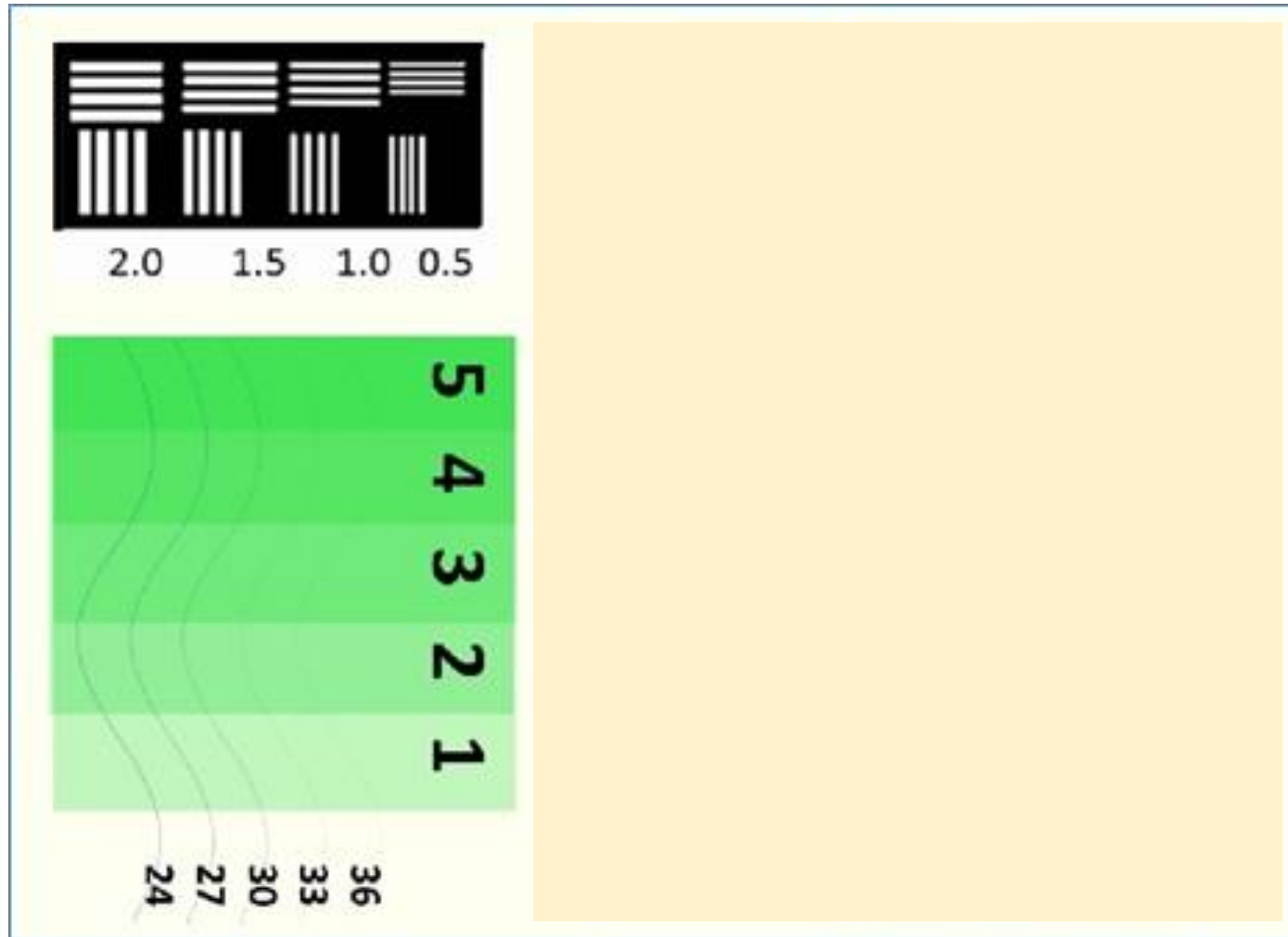


Round wire segments produce
“soft” edges



2.0 1.5 1.0 0.5

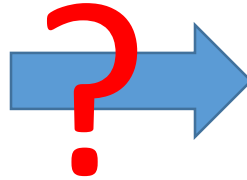
-HP revision status ...



Test 4 – simple penetration

1	1	2	2	3	3
4	8	2	6	0	4

Test 4



Outstanding questions:

1. **Step-thickness range** – upper right are two suggestions for expanding thickness range.
2. **Type of marker** - numeric, band, shape; choice of orientation.
3. **Material of marker** – Pb or steel (*n.b.* Pb has been used traditionally, but steel might be more relevant for Test 4, as copper is for Test 1).
4. **Placement of markers** – consider placing markers on each side of each step (as in the middle case), to evaluate the effect of build-up when barrier material is between: a) source and marker, and b) marker and detector.

42	45		▼	4
38	40		▼	4
34	35		▼	3
30	30		▼	3
26	25		▼	2
22	20		▼	2

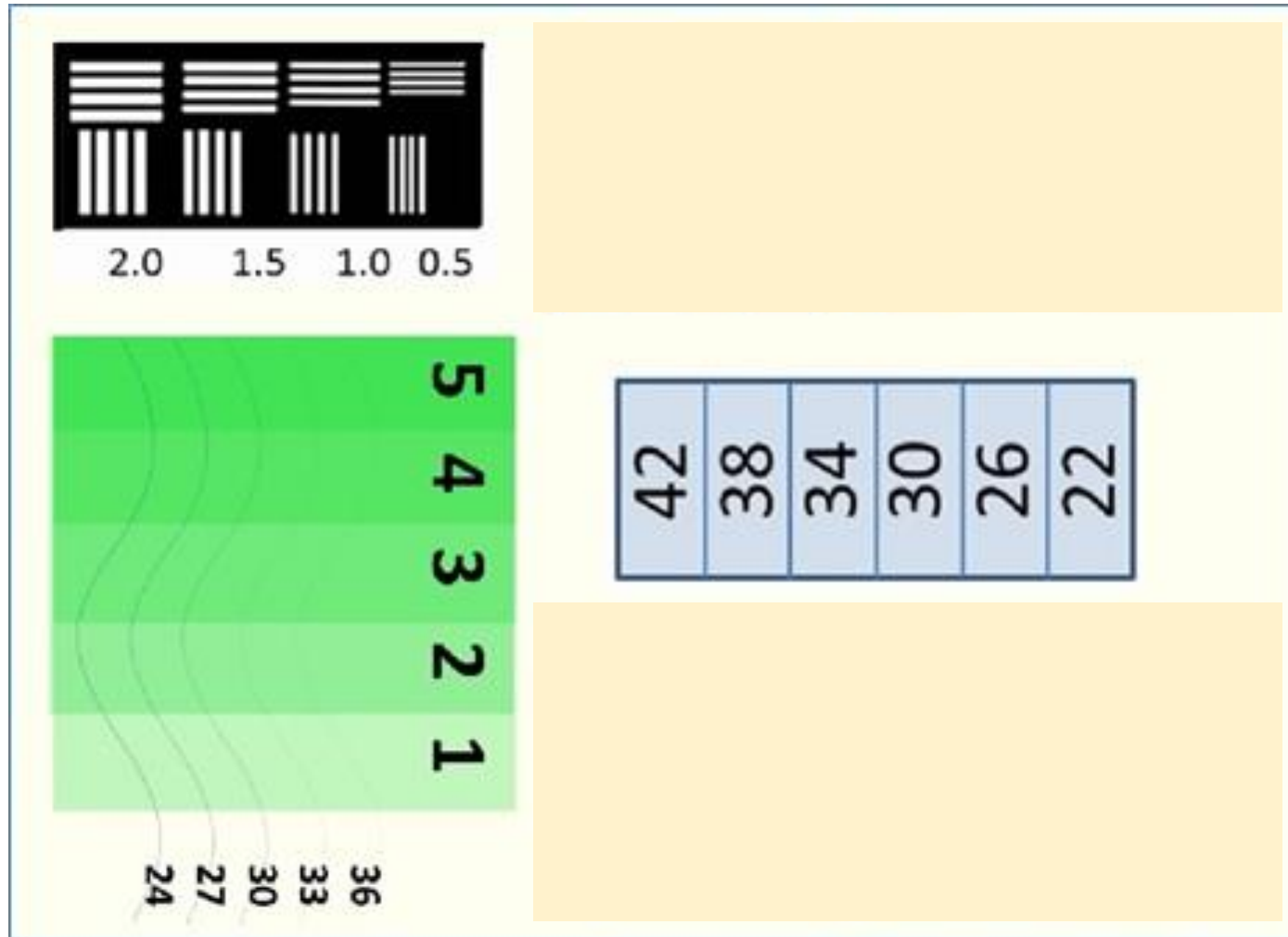
lead

steel

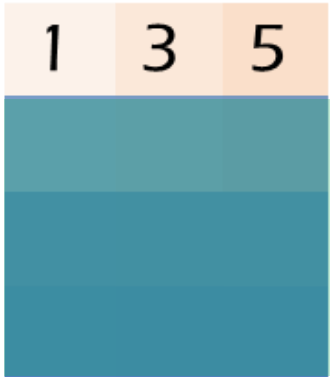
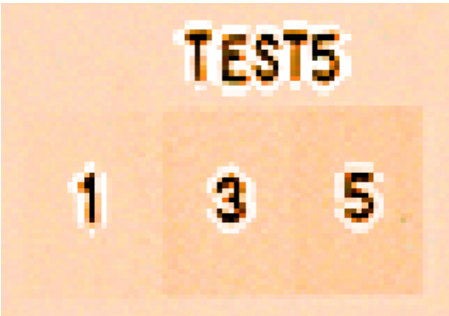
above

below (?)

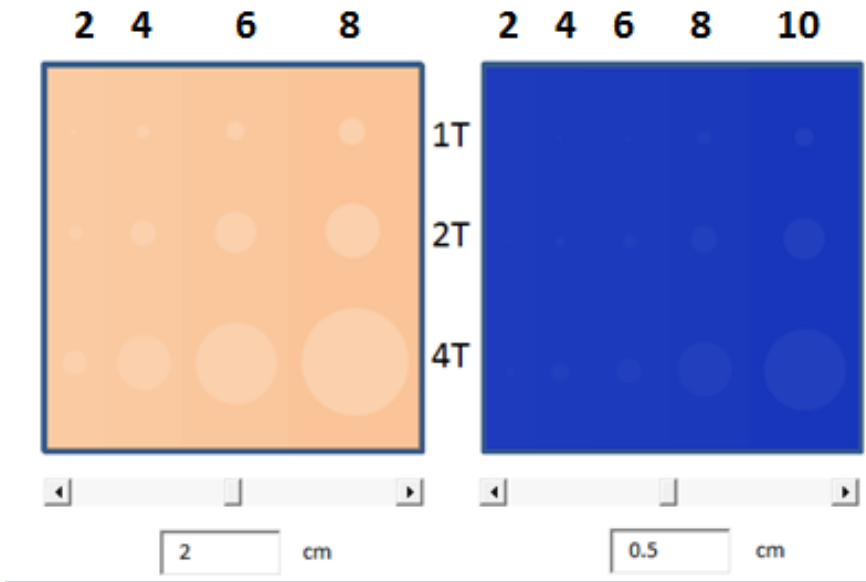
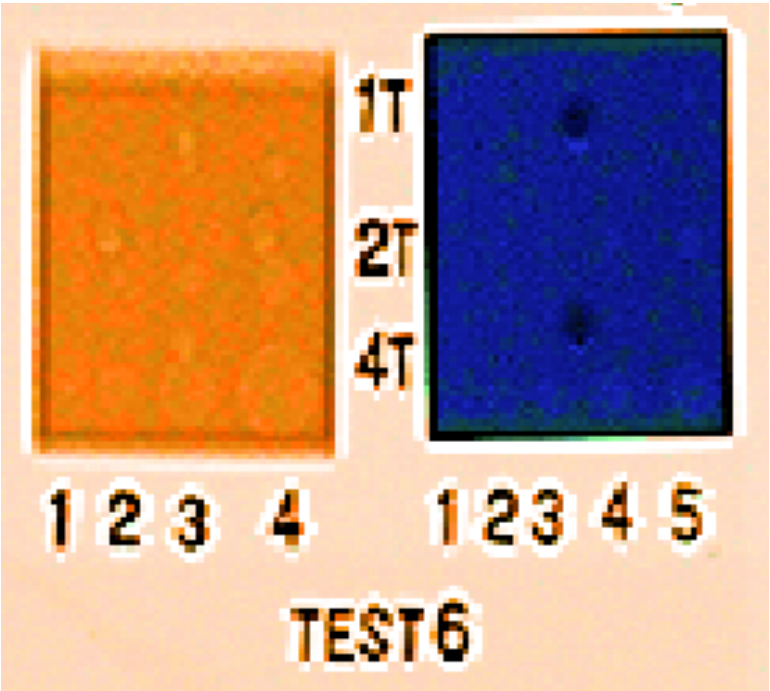
-HP revision status ...



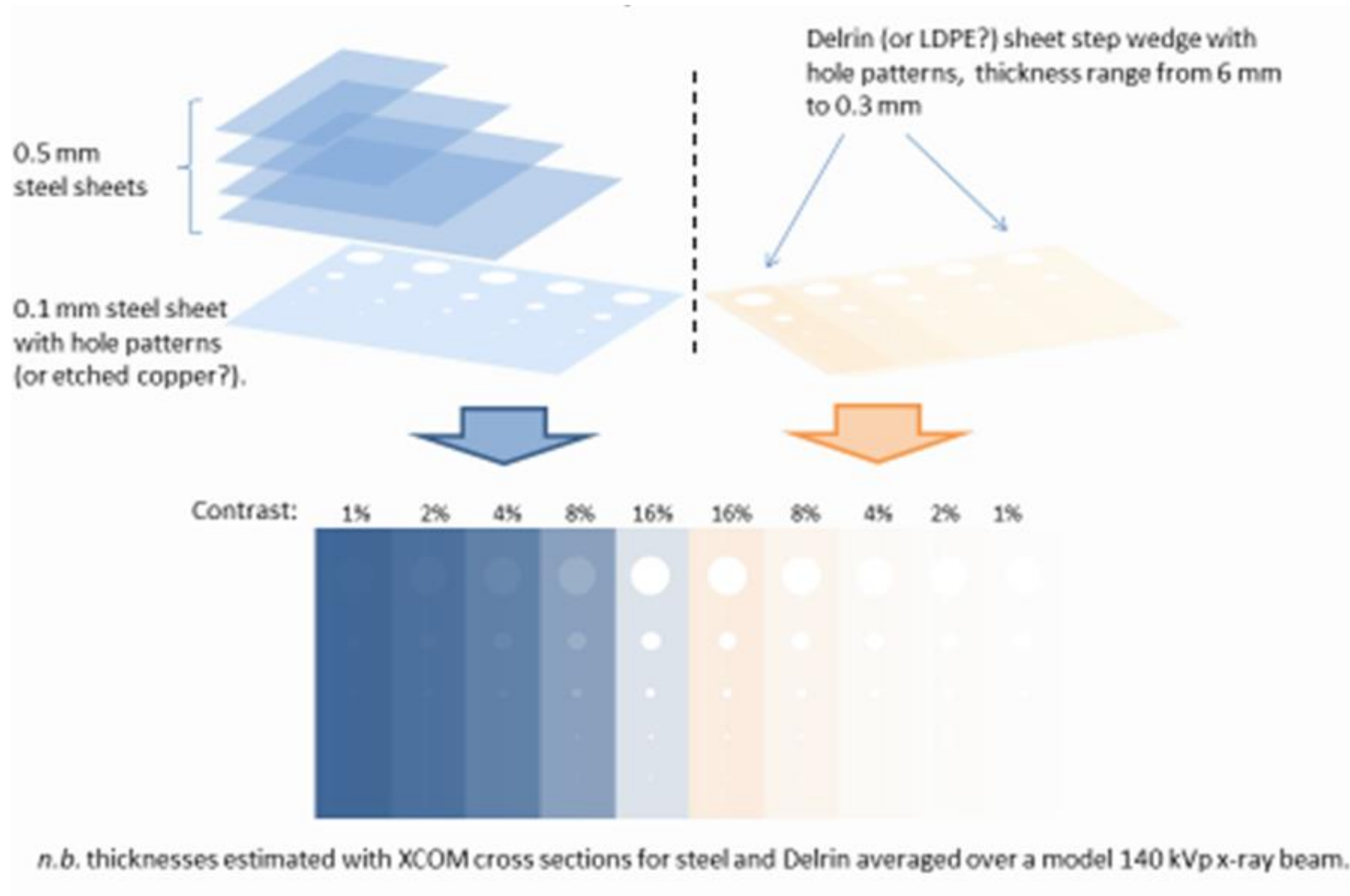
Tests 5, 6 – contrast sensitivity



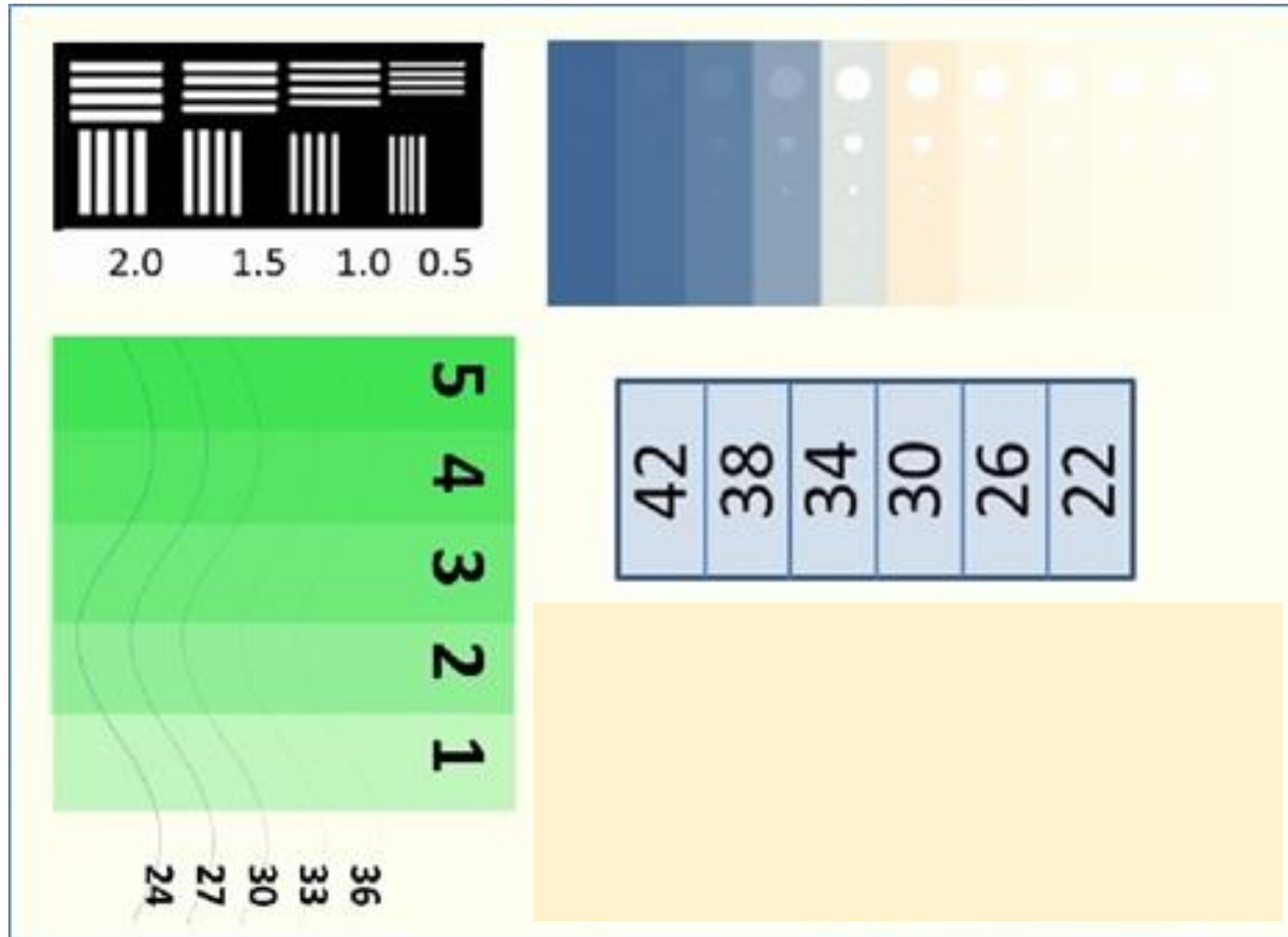
“Greening”



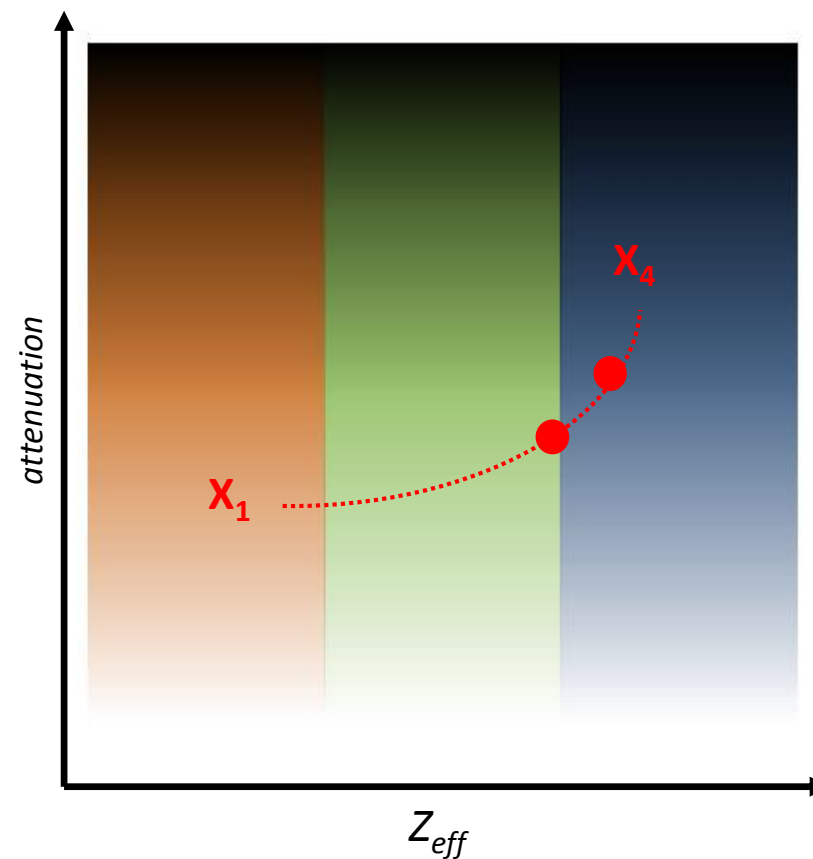
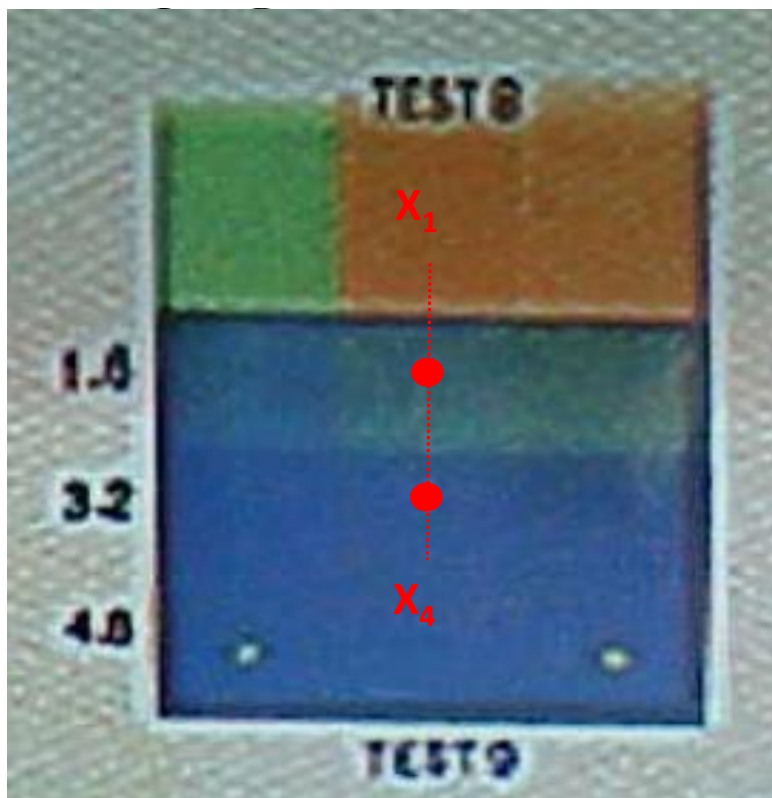
Tests 5, 6 – contrast sensitivity



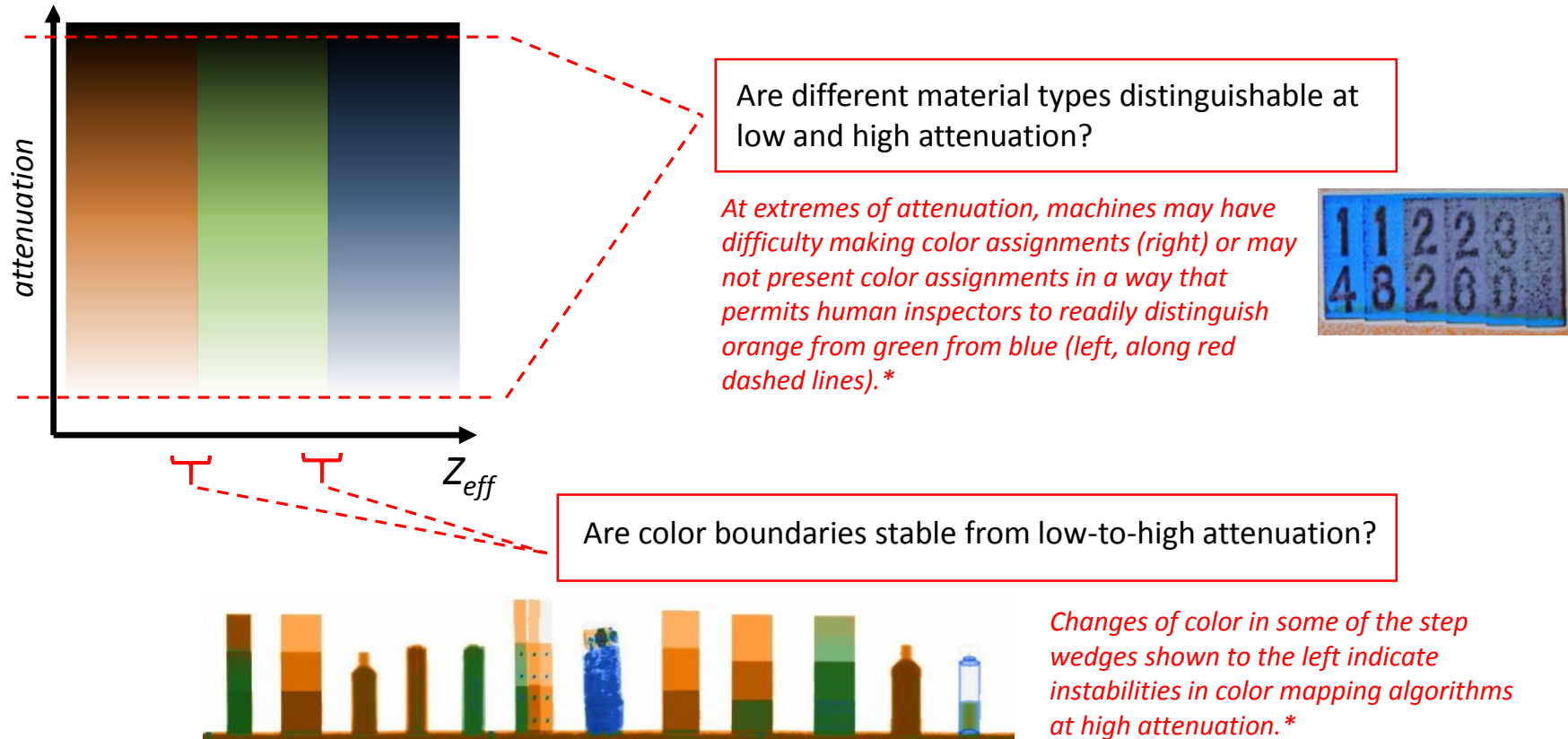
-HP revision status ...



Tests 8,9 – (useful) materials discrimination

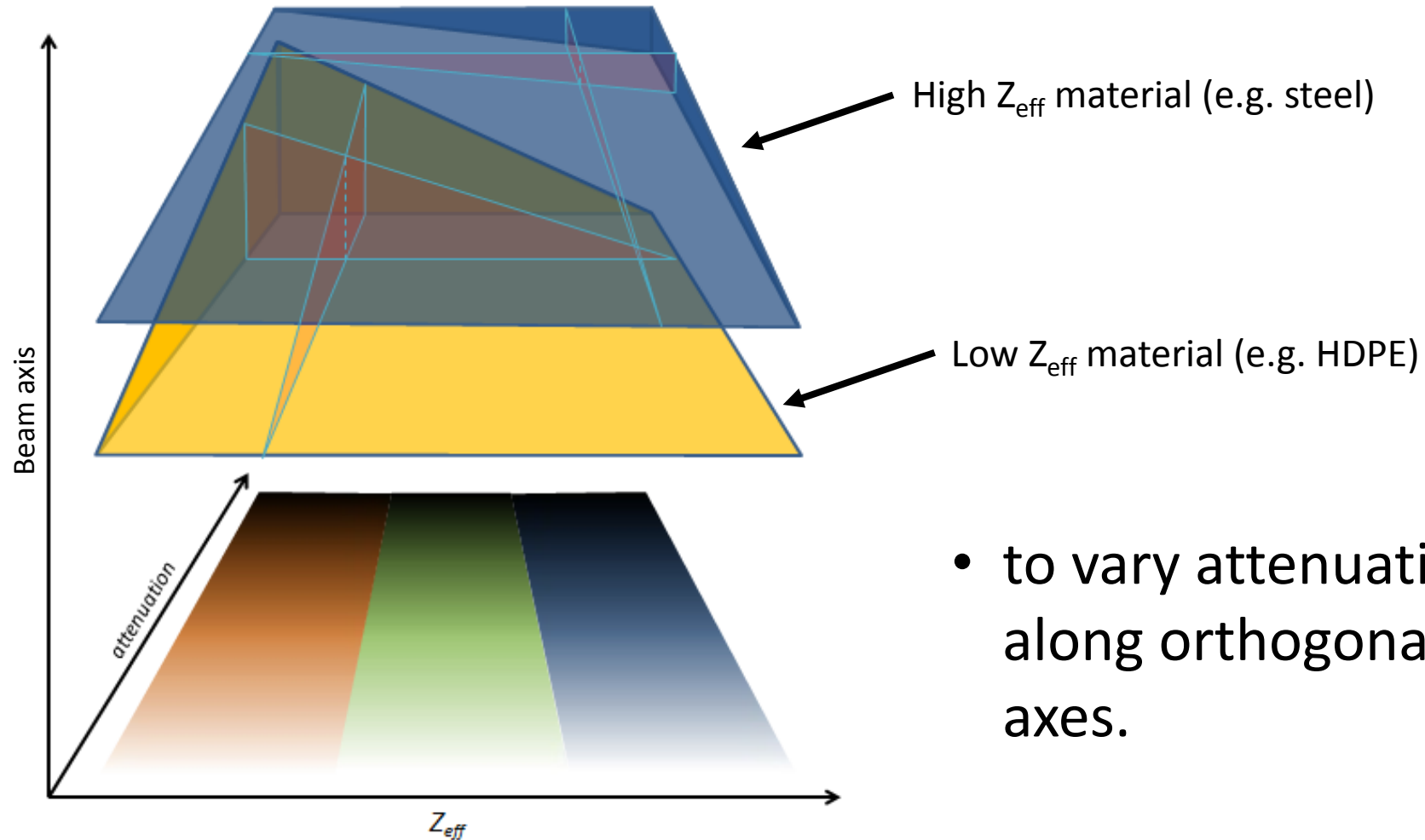


Tests 8,9 – ~~(useful)~~ materials discrimination



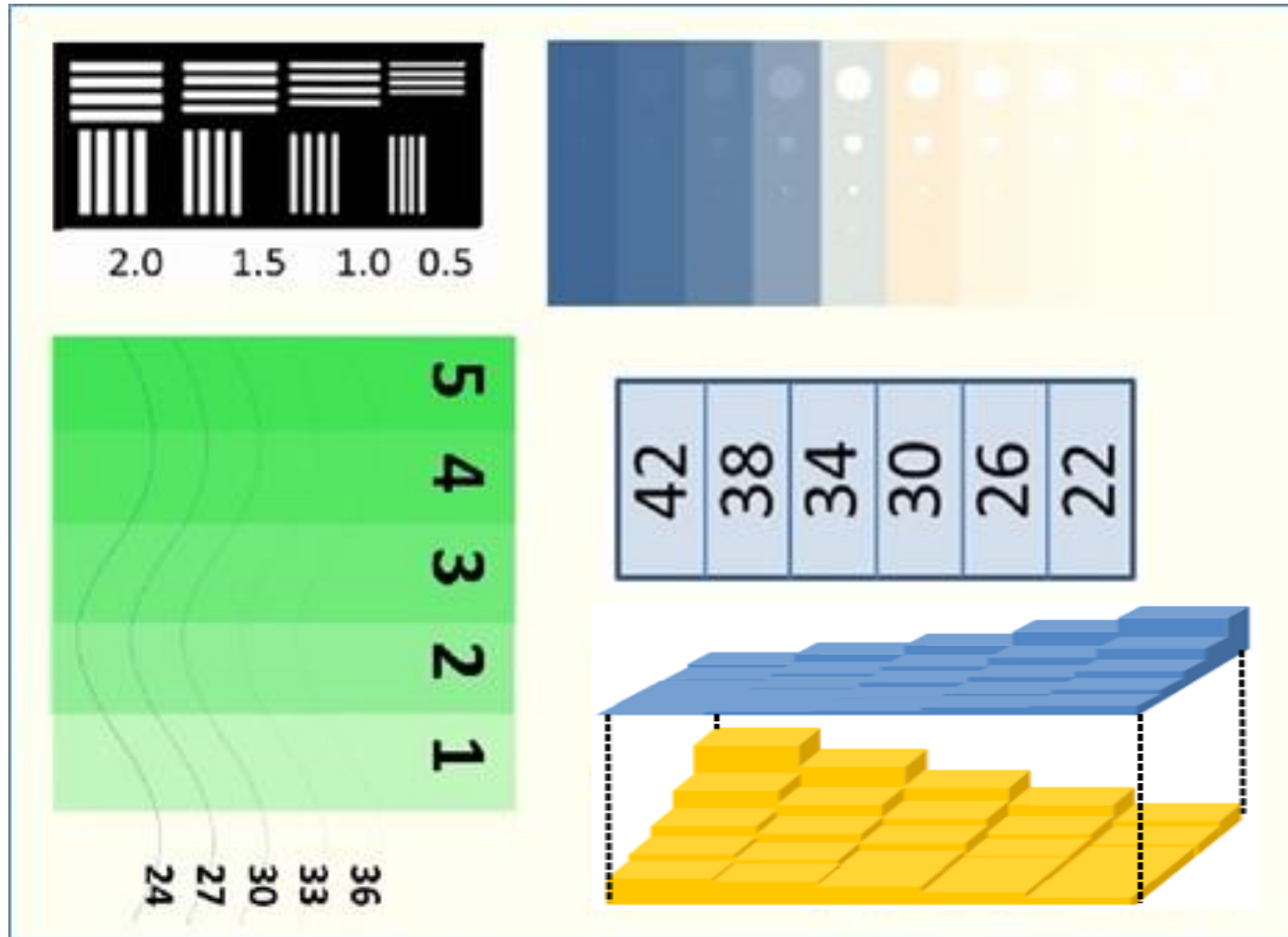
**Credit to Dudley Creagh (Univ. of Canberra) for both examples of imaging pathologies (n.b. the lower example was obtained from a cargo screening system).*

Tests 8,9 – materials discrimination

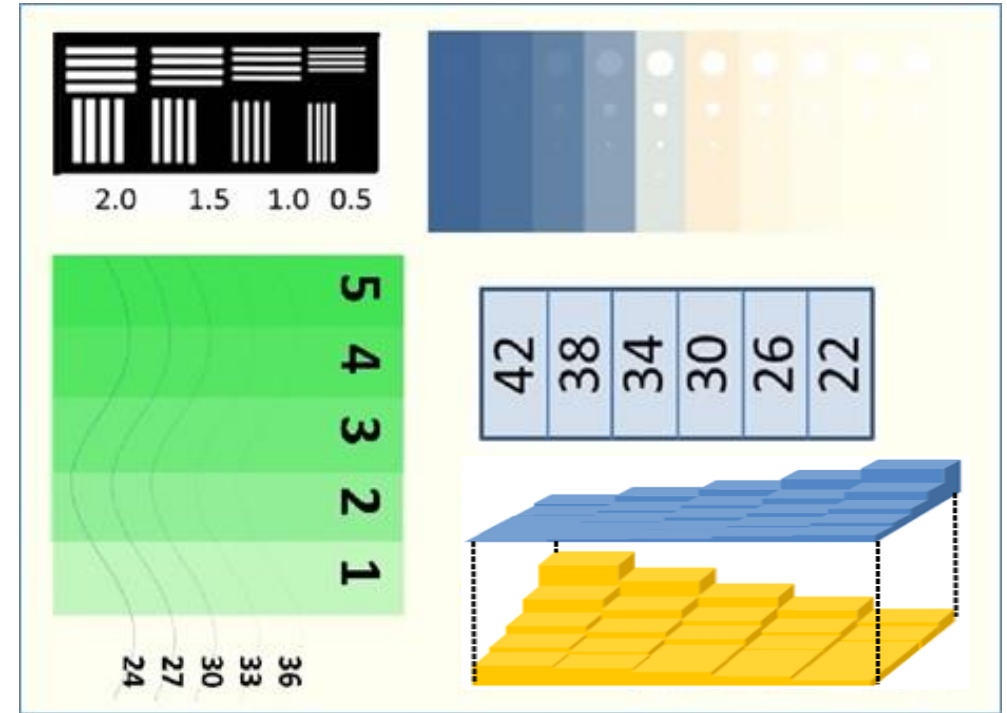
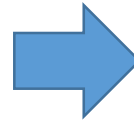
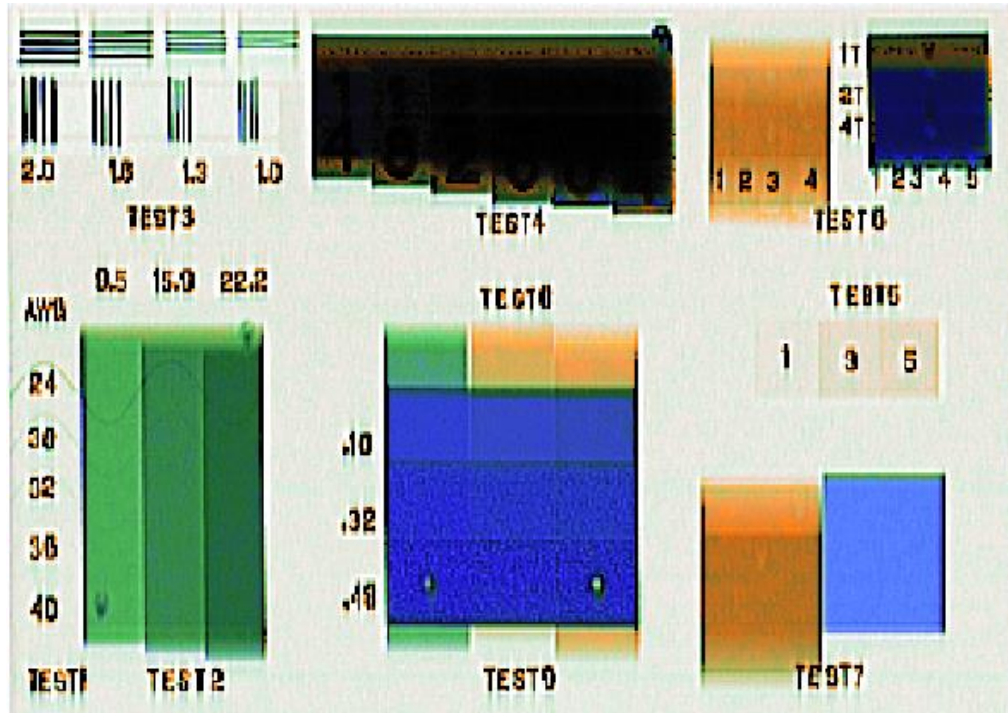


- to vary attenuation and Z_{eff} along orthogonal transverse axes.

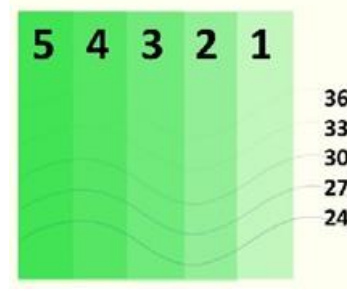
-HP revision status ...



-HP revision proposal ...



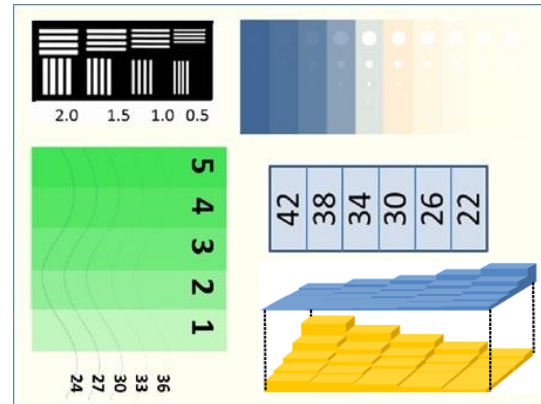
F792-revision vision...



-RTO

Acknowledgments

Nick Paulter (NIST)

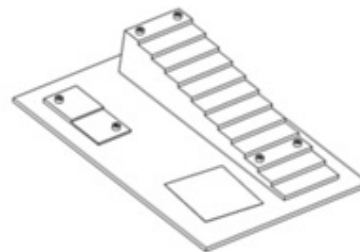


-HP

Fred Roder (SRA, Intl; TSL)

Jack Glover (NIST)

Dudley Creagh (U Canberra)



-OE

Jack Glover (NIST)

Larry Hudson (NIST)